The equation used is written $v=x+by+cz$. In which v is the variation of the minimum temperature from the evening dewpoint; b is the evening relative humidity, and c is the square of the relative humidity; x, y, and z are the three unknowns, which are evaluated from three normal equations which are readily written by the star point method, after the data have been properly charted.

The results are remarkably accurate. The studies show that the minimum temperature can be closely predicted in the orchard at considerable distance from the observing station; that the hygrometric observations made at noon may be used quite as well in some instances as those made in the evening, and that the equation will sometimes apply as well to cloudy as to clear nights.

DISCUSSION.

Prof. H. J. Cox remarked that the cranberry marshes of Wisconsin showed extraordinarily low temperatures, considering the high humidities, which condition he ascribed to the shallowness of the moist blanket of air.

Prof. W. J. Humphreys told of a case where, in order to protect his orchard, a farmer had driven his cattle and horses back and forth through the orchard, and the animal heat was sufficient to protect the trees against frost. This has the double advantage of supplying heat at moderate temperature in such a manner that it will not rise quickly above the trees, and of stirring the air.

FORECASTING FROSTS.

By B. A. KEEN.

[Discussed by J. Warren Smith.

(Nature, Jan. 1, 1920, p. 450.)

The author refers to different methods of frost protection and minimum temperature forecasting. Under frosts the writer says:

Up to the present, no complete correlation has been made of frost in any particular locality and its causes. For this purpose an examination by statistical methods of a series of continuous observations (of the automatic recording type) of meteorological factors is needed. The published papers deal usually with one factor, such as dewpoint or air temperature, and the number of daily observations made is small. This is due, no doubt, to the necessity of keeping the cost of apparatus and working as low as possible for the sake of the growers. However, a general idea of the factors concerned can be obtained from a broad survey of the various papers.

For several seasons the Weather Bureau has been making a careful temperature and frost survey in the citrus district at Pomona, Calif., and the deciduous fruit orchards near Medford, Oreg. Very valuable data have been collected on temperature differences as affected by topography, temperature fluctuations as affected by wind movement, changes in the dewpoint during the night, radiation with and without a smoke or smudge cover, and the temperature at different elevations when orchard heating is going on. A large number of thermometers have been exposed and special long-range thermographs kept in use. The radiation observations have been made with special apparatus used by the Solar Radiation Division of the Bureau. The work is now under the direction of Mr. Floyd D. Young, and the results will soon appear in print (in Farmers' Bulletin 1096).

One important result has been to show that so-called smudges are of small value as compared with the dry-heat method of orchard heating.

In connection with the forecasting problem Mr. Keen refers to a study by Hellman on the effect of an overcast sky on air temperatures near the ground. (Preuss. Akad. Wiss., Berlin, 38, 1918, p. 806); on various methods of predicting the minimum temperatures on radiation nights by Smith (U. S. MONTHLY WEATHER REVIEW 42, 1914, 573; 4, 1917, p. 402) and some observations by Franklin on the cooling of the soil at night, with special reference to late spring frosts. (Proc. Royal. Soc., Edin., 39, 1919, p. 120.)

The credit given J. Warren Smith in originating the median-hour method of predicting minimum temperatures should be only in the application of the idea which was first noticed by the writer in an article by E. A. Beals.

Referring to the study by T. B. Franklin, the writer says:

"As a result of observations of temperatures in the air, on the soil, and at a depth of 4 inches, Franklin concludes that a prediction of frost depends on assessing the value of: (1) Average relative humidity during the night; (2) the temperature of a given depth (4 inches) at the time of surface minimum temperature; (3) the conductivity of the layer between the assigned depth and the surface; and (4) the difference between the surface-soil minimum and that of the air above it. These determinations are necessary because: (1) The radiation from the soil on calm, clear nights is a function of the relative humidity (A. Ångström, Smithsonian Misc. Coll., 65 No. 3); (2) the radiation from the soil can be accounted for in balancing the upward conduction and the latent heat of freezing, the residue only cooling the soil; and (3) the temperature of the surface soil rapidly falls sufficiently below the temperature of the 4-inch depth to make the conduction from this depth balance the radiation; after this the surface temperature falls no faster than that of the 4-inch depth."

WINTER INJURY OF FRUIT TREES.

By JOSEPH ASKAMP.

(Abstracted from Circ. 87, 12 p., illus., Purdue Univ. Agr. Expt. Sta., 1918.)

The severe winter of 1917–18 has caused irreparable damage to thousands of peach and apple orchards in Indiana.[1] The heaviest toll was taken of the peaches, amounting all the way from very slight or no injury to the complete destruction of entire orchard tracts. It seems safe to say that for the State as a whole the damage has cut the bearing acreage of peaches at least 60 per cent. The mortality among young peach trees which had not yet borne fruit was small, however, so that in a short time normal production should be restored.

"A part of the acreage where the injury was severe will probably not be planted again to peaches. This is as it should be, for many of these locations were not well adapted to such a tender fruit. While the trees in many such locations were heretofore able to survive the winters, the buds or blossoms were more commonly killed than in more favorable situations. * * *

* * * "In the case of the apple, the young trees from 3 to 14 years old suffered the greatest injury. * * *

[1] During December and January unusually severe weather prevailed over the greater part of the country east of the Rocky Mountains, especially in the length of time that low temperatures were maintained and the large area involved. The cold weather continued into the first part of February in the northeast.

In Illinois the temperature fell to −23° F. in December and January and to −24° in February. A record of −30° was reached in Indiana in December, −24° in January, and −22° in February. In Ohio the lowest reported was −31° in December and −24° in January and February. The temperature fell to from 40° to 42° below zero F. at a number of places in the plateau districts of New York on December 30, and to below −30° during both January and February. (See MONTHLY WEATHER REVIEW, Dec., 1918, 46: 570-580.)—*J. W. S*

"Elevation and varieties were among the most important factors in influencing winter injury. A high location proved to be a decided protection for both peaches and apples. * * *

* * * "Other fruits are of relatively minor importance in Indiana and there are only isolated cases from which to draw information. Pears have been injured somewhat more than apples. Sweet cherries were next in tenderness to the peach. Sour cherries suffered no permanent injury, although in one poor location sapwood killing in spots was evident, The plums were not quite so hardy as the apples, except the American varieties, which came through practically uninjured."

"The most severe injury in both the peach and apple originated in the trunk and main branches. This was undoubtedly due to the degree of maturity, as these portions of the tree would be the last to ripen. * * *

"Aside from elevation and variety, the hardiness of the tree was influenced by the growth conditions prevailing during the summer of 1917; that season was short and wet. It is probable that many trees failed to mature their wood properly. Had a normal growing season preceded the severe winter, there might have been no killing in the apple. Thus, even should a like winter come again, unless it were preceded by a similar growing season, the results would not necessarily be duplicated. The chance, therefore, of apples again winter-killing to a similar degree are small."

The balance of the circular is devoted to descriptions of injuries, the best methods of caring for the injured trees, and the insects associated with winter injury.—*J. Warren Smith.*

THE WORK OF THE U. S. WEATHER BUREAU IN THE WEST INDIES.[1]

By OLIVER L. FASSIG, Meteorologist.

[Dated: Weather Bureau, San Juan, P. R., Dec. 1919.]

During the Spanish-American War the presence of a large fleet of our naval vessels in the tropical waters to the south urgently called for special protective measures in the Gulf of Mexico and the Caribbean Sea. In June, 1898, Congress authorized the Weather Bureau to establish and operate weather-reporting stations at selected locations in the islands of the West Indies and along the adjacent coasts of the Caribbean Sea and the Gulf of Mexico.

While the primary object of the new service was the protection of the naval forces of the United States, additional arguments were the greater protection against loss by storm along our own Gulf coast and the coast of the south Atlantic States, as well as the necessity for additional safeguards to the rapidly growing commercial interests in these waters with the opening of the Panama Canal.

Skilled observers of the Weather Bureau were located at 10 well-distributed points within the hurricane area, with instructions to report weather conditions twice daily by cable to Washington from June 1 to November 30, the period during which the severe atmospheric disturbances known as hurricanes may be expected to occur. All reports were cabled to Washington headquarters of the Bureau, where the observations were charted, forecasts were prepared, and warnings issued in case of disturbed conditions arising in any portion of the area.

Soon after our entry into the World War steps were taken by the Chief of the Weather Bureau, Prof. Marvin, to increase the number of storm-warning stations within the hurricane area, and to-day the Weather Bureau has 30 stations on the islands of the West Indies and along the adjacent shores of the Caribbean Sea from which reports are cabled to Washington at 8 a. m. and 8 p. m., Washington time, during the hurricane season, and at which daily records are maintained throughout the year. Within the past year the eastern portion of the area, including the Lesser Antilles and Porto Rico—the gateway to the hurricane belt—has been made a separate forecast district, with San Juan, P. R., as district center.

The system outlined above was inaugurated and maintained primarily as a storm-warning organization, and only incidentally as a climatological service. In the spring of the present year (1919) Prof. Marvin, in view of the growing importance of the commercial and agricultural interests of the area, inaugurated a climatological service, including all of the islands of the West Indies and the adjacent coasts of Central and South America—an area extending from approximately longitude 60 to 90 degrees west, and from latitude 10 to 25 degrees north, or roughly from Barbados, at the extreme east to Panama, and from Curaçao, off the north coast of South America, to Nassau in the Bahama Islands.

Climatological services of large or small extent are maintained in nearly all of the islands of the West Indies under the supervision of their respective local governments, but it is extremely difficult, if not impossible, to get access to the observations made under systems not in accord in methods and measures, or in the absence of regular and systematic publication of results.

Soon after acquiring possession of the Island of Porto Rico as a result of the Spanish-American War in 1898, a climatological service of the Weather Bureau was inaugurated on the Island along lines similar to the climatological sections so familiar to all in the States. This service has been maintained without interruption to the present time, a period of more than 20 years. Records of the weather are made and recorded daily at 60 stations and published monthly.

The first efforts to extend the climatological service to the other islands of the West Indies were initiated during the present year, and arrangements have already been completed to establish 18 stations in our recently acquired Virgin Islands—5 on the Island of St. Thomas, 3 on the Island of St. John, and 10 on the largest and by far the most productive of the islands, St. Croix. Arrangements have also been completed to establish 30 stations in Haiti, with the cordial cooperation of the Haitian Government and officials of the U. S. Navy. From 30 to 40 stations are planned for Santo Domingo.

In the islands referred to above the organizations will be under direct control of the U. S. Weather Bureau. As efficient climatological organizations already exist in Cuba, Jamaica, and the English and French islands of the Lesser Antilles, the plans of the Chief of the Weather Bureau provide for intimate cooperation with the directors of these foreign services with a view to securing a sufficient number of cooperating stations to represent fairly the climatological conditions of their respective islands.

[1] Read at the joint meeting of the American Meteorological Society and the Association of American Geographers, St. Louis, Dec. 31, 1919.